power, the difference between the refractive indices of the object and its surrounding medium, and the object dimensions.

Alternatively, magnetic tweezers trap magnetic micro-particles in tailored magnetic field gradients. Due to the magnetic anisotropy inherent in the particles, rotation of the magnetic poles generating the magnetic field gradients that capture the particles imparts torque to the micro-particles and, consequently, to any biological molecule attached to the micro-particles. This torsional motion can be used to stretch, twist, or uncoil biological molecules. The size of the particle used in this set-up can be smaller than that used in optical tweezers and are typically compatible with invivo restrictions. A disadvantage with this type of tweezers is that one end of the biological molecules must be attached to a fixed point, typically a microscope slide.

Currently, most single molecule manipulation techniques are limited to studying one molecule at a time, which limits the throughput to typically one molecule per apparatus per day. In the case of magnetic tweezers, permanent immobilization of the molecule, which hinders the molecule from being moved for further analysis or exploitation, is necessary for performing experiments.

DISCLOSURE OF THE INVENTION

According to various features, characteristics and embodiments of the present invention which will become apparent as the description thereof proceeds, the present invention provides a microchip based platform that allows for high-throughput analysis of individual biological, biochemical or chemical particles, including polymers, molecules and groups of such particles without impairing the mobility of the sample and while ensuring adequate spacing between particles or molecules so that a large number of individual and parallel experiments can be performed on a rapid time scale.

The present invention further provides a high-throughput and low power consumption platform for sorting and probing biopolymers and other biological molecules, chemical compounds, etc one or more molecules at a time.

The present invention also provides methods and apparatuses that allow temporary and selective immobilize of individual samples in a discrete matrix.

The present invention further provides for methods and apparatuses for applying torsional forces to individual biological, biochemical or chemical particles, polymers and molecules.

The present invention also provides for methods and apparatuses for applying rotational forces to individual biological, biochemical or chemical particles, polymers and molecules.

According to one specific embodiment, the present invention provides a microfluidic platform for selectively capturing and releasing magnetic particles which includes:

a substrate supporting a membrane over at least one opening in the substrate; and

a plurality of spin-valve elements provided on a supported portion of the membrane,

the plurality of spin-valve elements each comprise a discrete layer of a material that, when subjected to an applied magnetic field produces a local magnetic field that is capable of attracting and restraining magnetic particles near the spin-valve elements.

According to another embodiment, the present invention provides a spin-valve platform that includes:

a membrane having opposite side surfaces; and

a plurality of spin-valve elements provided one of the opposite side surfaces of the membrane,

the plurality of spin-valve elements each comprising a discrete layer of a material that, when subjected to an applied magnetic field produces a local magnetic field that is capable of attracting and restraining magnetic particles near the spin-valve elements.

According to yet another embodiment, the present invention provides a method of manipulating magnetic particles which involves:

providing a plurality of magnetic particles;

dispersing the magnetic particles in a fluid;

providing an array of spin-valve elements which comprise discrete substantially coplanar layers of a material that, when subjected to an applied magnetic field produces a local magnetic field that is capable of attracting and restraining magnetic particles near the spin-valve elements;

applying an applied magnetic field to the array of spin-valve elements; and

bringing the fluid having the magnetic particles dispersed therein near the array of spin-vale elements so that at least one or more of the magnetic particles are held by the local magnetic fields of one or more of the spin-valve elements.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will be described with reference to the attached drawings which are given as non-limiting examples only, in which:

FIG. **1** is a perspective view of a portion of a micromachined magnetic trap platform according to one embodiment of the present invention.

FIG. **2** is a cross sectional view of the micromachined magnetic trap platform of FIG. **1**.

FIGS. **3**A-**3**E depict one manner of fabricating the micromachined magnetic trap platform of FIG. **1**.

FIG. **4** is a schematic side view of a spin-valve trap according to one embodiment of the present invention.

FIG. **5** is a schematic side view of a spin-valve trap according to another embodiment of the present invention.

FIG. **6** is an M-H curve of a spin-valve element according to one embodiment of the present invention.

FIG. **7** depicts how magnetic particles are can be sorted and positioned in a stationary array by one of the spin-valve elements of the present invention.

FIGS. **8**A-**8**C depict how a biopolymer (DNA) that is held by opposite ends by separated spin-valve elements can be rotated about various coordinate axes.

FIGS. **9**A-**91** depict a sequence of a magnetic particle confined by a field gradient produced by a spin-valve element during rotation of an applied auxiliary magnet field.

FIG. **10**A depicts an initial random distribution of particles before being sorted by an array of spin-valve elements.

FIG. **10**B depicts the particles of FIG. **10**A after they have been sorted.

FIG. **11**A depicts how a particle can be moved into a desired portion using a magnetic tipped probe.

FIG. **11**B depicts the magnetic tipped probe and array of spin-valve elements of FIG. **11**A in perspective.

FIG. **12** shows the force versus distance simulations for a conical and truncated tip with an 800 run diameter and a 1 μm diameter magnetic particle.

FIG. **13** shows a magnetic random access molecular manipulator according to one embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

The present invention provides a microfluidic platform that incorporates a platform consisting of a super array of spin-